SCIENCE LIBRARY
DEC 3 1926
anal 0
382-399

Technical Paper 382

DEPARTMENT OF COMMERCE
HERBERT HOOVER, SECRETARY

U.S. BUREAU OF MINES
SCOTT TURNER, DIRECTOR

ACCIDENTS IN THE CALIFORNIA PETROLEUM INDUSTRY IN 1923

BY

H. C. MILLER and C. E. STEIDEL

PRICE 5 CENTS
Sold only by the Superintendent of Documents, Government Printing Office
Washington, D. C.

WASHINGTON
GOVERNMENT PRINTING OFFICE
1926

U.S. Govt
10-26-1926

CONTENTS

	Page
Preface	IV
Introduction	1
Acknowledgments	3
Source and scope of statistics	3
Drilling and producing accidents	4
Causes of injuries and extent of disability	9
Part of body affected	10
Average number of days lost per accident	10
Classification of oil-field labor	11
Accidents caused by the machinery at drilling and producing wells	12
Pipe-line and transportation accidents	13
Causes of injuries and extent of disability	16
Part of body affected	17
Average number of days lost per accident	17
Classification of pipe-line and transportation labor	18
Refinery accidents	19
Causes of injuries and extent of disability	22
Part of body affected	23
Average number of days lost per accident	24
Classification of refinery labor	24
Sales and marketing accidents	25
Causes of injuries and extent of disability	28
Part of body affected	28
Average number of days lost per accident	29
Classification of sales and marketing labor	30

PREFACE

A review of the petroleum industry in California in 1923 shows that the production and distribution of 262,876,000 barrels of oil from wells within the State were accompanied by accidents that resulted in the loss of 75 lives and in injury to 8,432 employees, exclusive of minor injuries that caused disablement for less than one day. The accidents during the year caused a loss of time equivalent to 669,407 man days of labor. These figures are based on an examination of reports made by operating companies to the Industrial Accident Commission of California.

In view of the accident-prevention work done in California by the industry and by the industrial commission of the State, it is believed that the losses from accidents there are fairly indicative of similar losses in other petroleum-producing States. Evidently much labor is lost and much personal suffering is caused each year by accidents that attend the production and distribution of the Nation's oil and oil products. Many of the accidents may properly be classed as "preventable."

The aim of the Bureau of Mines in publishing this report is to make available, in definite and concrete form, a reliable basis for the work of safety engineers and others interested in the prevention of accidents in the petroleum industry. The bureau hopes that this report will aid the establishment of a uniform method of presenting facts statistically so that progress in accident-prevention work may be accurately gauged and fair comparisons made as between companies in the same State or in different States and as between the entire industry in one State and in another State. Efforts at accident prevention based on sound judgment and on accident statistics carefully and uniformly compiled should attain the desired results with the greatest economy of time, money, and effort.

SCOTT TURNER, *Director.*

ACCIDENTS IN THE CALIFORNIA PETROLEUM INDUSTRY IN 1923

By H. C. MILLER and C. E. STEIDEL

INTRODUCTION

In any industry the basis of effective work for the prevention of accidents must be a thorough understanding of the occupational hazards; without this knowledge no real progress in the elimination of accidents is possible. A statistical study of accidents grouped by causes and occupations shows the risks involved and indicates where improvement is most urgently needed. It is essential that accident statistics shall be compiled on a uniform plan by the individual companies and operators and by State and Federal organizations, in order that the hazards of different occupations in different fields or different States may be fairly compared.

The scheme of accident tabulation outlined in this report has been adopted by several California oil companies and has met their requirements. It is hoped that other companies will adopt this plan, in order that, as the safety movement gains momentum, the records of companies, or of departments within a company, or of individual companies may be compared with those of the State as a whole. A uniform plan of accident classification in the petroleum industry, if adopted by all States where such accidents occur, would be of especial value in permitting comparison of the records of different States.

In the tables that follow no attempt has been made to schedule the number of accidents per unit of men employed (frequency rate) or the number of days lost per unit of time (severity rate).

There is no agency in California, private, State, or national, to which the companies and operators report the number of men in their employ or the number of hours these men are exposed to occupational hazards. Several California petroleum companies, however, have adopted for their own information the policy of expressing their accident-frequency rates in terms of the number of lost-time accidents per million hours' exposure of the working force

Original from UNIVERSITY OF MICHIGAN

and their severity rates in terms of the number of days lost per thousand man hours worked. This method of reporting frequency and severity rates is in line with recommendations of the International Association of Industrial Accident Boards and Commissions, the United States Department of Labor, Bureau of Labor Statistics, and the National Safety Council. Only on such a basis can progress in accident prevention best be gauged and a true comparison be made between the records of two companies or between departments within the same company.

In this report the time lost by temporary disability is the actual duration of the disability in working days. No accident has been considered unless the resultant time lost was longer than the day on which the injury occurred. Hernia is considered a temporary disability on the basis of actual time lost. For fatalities and permanent disabilities the weighting table used by the Industrial Accident Commission of California, which is based on the table advocated by the International Association of Industrial Accident Boards and Commissions, is used. In this table a death or permanent total disability is weighted as 6,000 days lost and permanent partial disabilities are weighted as percentages of permanent total disabilities.

Permanent partial disability includes all accidents resulting in the loss of one foot, leg, arm, hand, eye, one or more fingers, one or more toes, any dislocation where ligaments are severed, or any injury known in surgery to be a permanent partial disability. The duration of disability for accidents of this latter type is taken as the period for which compensation is payable under the laws of California.

For the purpose of this report the California petroleum industry was divided into four main divisions, as follows: Drilling and producing, pipe line, refinery, and sales or marketing. It was impossible from the records available to segregate further any division into that phase of the work ordinarily included under engineering and construction work. For this reason the number of accidents in the pipe-line and transportation division and in the refinery division is naturally high, as much new construction work was done during the year 1923. Many new tanks were erected in the pipe-line division, new refineries were built, and others enlarged. This fact will not alter the value of this report, because such construction work is more or less constant in these divisions, though it is usually on a smaller scale or is spread over a longer period of time. No attempt was made to include in this classification any marine accidents, as the reports of accidents on oil tankers and ships were in the main incomplete.

Table 1 shows the number of accidents, the resulting days lost, and the corresponding percentages for all the divisions of the California petroleum industry during 1923.

TABLE 1.—*Number of accidents and days lost with percentages for all divisions of the California petroleum industry for calendar year 1923*

Division	Number of accidents	Per cent of total accidents	Number of days lost	Per cent of total time lost
Drilling and producing	6,310	74.18	522,751	78.09
Pipe line and transportation	667	7.84	39,826	5.95
Refinery	930	10.93	72,620	10.85
Sales and marketing	600	7.05	34,210	5.11
All divisions	8,507	100.00	669,407	100.00

In addition to the total accidents given in Table 1 there were 218 in the drilling and producing, 6 in the pipe-line and transportation, 14 in the refinery, and 10 in the sales and marketing divisions which could not be classified on account of the lack of sufficient data on the original accident reports.

ACKNOWLEDGMENTS

The writers acknowledge the courtesy of the commissioners of the Industrial Accident Commission of California for the permission they granted to gather from their files the data upon which this report is based. The writers are also deeply indebted to E. G. Sheibley, T. W, Osgood, G. Chester Brown, J. Wesley Gebb, and C. R. MacDonald, of the Industrial Accident Commission; to Roy Kelly, manager, industrial relations, Associated Oil Co.; to members of the safety board, Union Oil Co., especially Ralph Reed and George F. Prussing; to the officials of the safety division, personnel department, Standard Oil Co. of California; to C. C. Scharpenberg and Arthur Johnson, of the producing department, Standard Oil Co. of California; to J. L. Glennon, superintendent, department of safety, General Petroleum Corp.; to W. W. Adams, J. R. Reeve, B. O. Pickard, F. C. Gregory, H. C. Fowler, and C. P. Bowie, of the Bureau of Mines; and to F. B. Tough, formerly of the bureau.

SOURCE AND SCOPE OF STATISTICS

The tables that follow present statistics of industrial injuries sustained by employees of the California petroleum industry during the calendar year 1923. The records of these accidents were compiled from data taken from the accident reports sent by operators to the Industrial Accident Commission of California. These data have been tabulated to show the cause of the accidents, part of the workman's body affected, time lost in days, and occupation of the injured for each of the four main divisions of the oil industry. This work should prove valuable to the officials and safety engineers of the oil companies, in that it shows the cause and gravity of all accidents to employees of oil companies, regardless of the magnitude of their operations. A study of the tables will enable those interested in accident prevention to base their efforts on something tangible and extensive enough to represent average conditions in California. These tables will familiarize an employee with the frequency and seriousness of the accidents which happen around him every day and should tend to acquaint him with the true nature of the hazards of the work in which he is engaged.

The loss of 669,407 working days represents the work of approximately 2,000 men for one year, and if the scope of this report admitted converting this time in days lost into equivalent dollars and cents there would still have to be taken into consideration such factors as hospital and medical fees, the indirect cost which every accident brings in suffering to the injured and his dependents, and the decreased morale of the workers associated with the injured.

The benefits of accident prevention are threefold: (1) They lower costs to the employer, (2) the employee is spared suffering and reduction of wage-earning ability, and (3) the community at large profits because less caring for the maimed and disabled is required. Safety measures therefore justify their existence and should be furthered vigorously by every executive and employee.

DRILLING AND PRODUCING ACCIDENTS

Table 2 classifies accidents to drilling and production employees as to cause. It should be noted that the machinery at drilling and producing wells was responsible for 20.27 per cent of the total number of accidents and for 36.71 per cent of the total time lost in days. Not all of these accidents could have been prevented, though adequate guards would have eliminated a large percentage. Accidents at draw works caused the most loss of time. The data show that the most dangerous single piece of machinery is the rotary draw-works cathead. Seven fatal accidents resulted from workers getting caught in the catline or between the catline and the cathead. In six of these the injured man was drawn into the cathead, where an arm or leg was severed or other bodily injuries received which resulted in death. Such accidents as are caused by the bursting of rotary brake-drums, breaking of sprocket chains, or workmen getting caught in chains and carried into sprockets, plus those caused by the catheads, comprise nearly all the serious draw-works accidents. Most of these could have been avoided.

Breaking of lines caused injuries that brought about 12.78 per cent of the days lost at the wells, although the number of accidents from this cause represents only 2.66 per cent of the total. The few accidents caused by lines breaking were serious and entailed great loss of time. The number of such accidents can be materially reduced by frequent and thorough inspection of the sand, casing, cat, and jerk lines and rejecting for further use those which show wear. Prevention of one accident may pay for several new lines.

Casing and tubing tongs were responsible for the greatest number of machinery accidents at the drilling and producing wells. Most of these accidents can be prevented by educating employees to step outside the danger zone when drill pipe, tubing, or casing is being made up. A number can be prevented by providing safety lines of ample strength for the lead and back-up tongs or by using a "cart-wheel" guard on the rod wrench when rods are broken.

Elevators ranked second in numerical importance as a cause of machinery accidents at wells. The injuries caused were usually due to workers getting their fingers or toes between a descending elevator and the rotary table or between the elevator and the slips. Here, again, an educational campaign can accomplish much good. The workmen should be shown the right and wrong way of doing their work and if necessary frequently reminded of the former, so that keeping their fingers and toes out of the danger zone will become a habit. Employers can help in another way to prevent many of these accidents by equipping the slips with long handles, so that there can be no possibility of the elvators mashing hands or fingers. To many workers on the derrick floor such suggestions may seem trivial, but statistics show that more care and concentrated thought are necessary if such accidents are to be eliminated.

During 1923 eight men fell from derrick platforms and were killed because they failed to wear safety belts—inexcusable carelessness from the safety man's viewpoint. Six men were killed by material falling from the derrick onto those below. Accidents of this nature are usually due to a fellow worker's carelessness and can not always be blamed on the one who was killed. The practice of leaving material and tools loose above the derrick floor should not be tolerated. When tools are used overhead they should be returned to the floor immediately after use and not allowed to remain on the double or fourble board platforms or elsewhere in the derrick whence they may fall when dislodged by vibration of the derrick during drilling or by other causes. The decking plank of all derrick platforms should be bolted to the derrick girts, so that if struck and broken by the traveling block, elevator, or stand of pipe it will not fall and cause an injury to those below. A wire nailed or otherwise securely fastened to the end of the finger board and tied to a derrick member will prevent a loosened finger board from falling. Every well crew should make sure that everything overhead is securely fastened before doing any work on the derrick floor. The time taken to send a man to inspect a derrick is nothing compared to the delay an accident may occasion.

Employers should effect the sincere coöperation of employees in the prevention of accidents, but they must not overlook the fact that before most workers will accept the principles of accident prevention the working places must be made safe.

Table 2 classifies the 6,310 drilling and production accidents. The causes of the accidents have been grouped in 16 main divisions, each with one or more subtitles. In addition to showing for each division the total number of accidents and days lost, with percentage of the total, the accidents listed have been further segregated to show the part of the body affected.

TABLE 2.—*Drilling and producing accidents, classified by causes*

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Foot, ankle, toes	Legs	
All causes										
All causes	[1] 6,310	644	264	266	519	1,679	1,002	1,311	624	522,751
Per cent	100.00	-----	-----	-----	-----	-----	-----	-----	-----	100.00
Heavy lifting and straining										
Heavy lifting and straining	525	-----	-----	-----	57	16	431	1	20	8,767
Per cent of grand total	8.32	-----	-----	-----	-----	-----	-----	-----	-----	1.68
Dropping objects or materials handled										
Dropping objects or materials	394	-----	1	-----	3	75	6	286	23	5,634
Per cent of grand total	6.24	-----	-----	-----	-----	-----	-----	-----	-----	1.08
Stepping on objects										
Nails	150	-----	-----	-----	-----	-----	-----	150	-----	1,583
Miscellaneous	70	-----	-----	-----	-----	1	6	56	13	903
Total	226	-----	-----	-----	-----	-----	-----	-----	-----	2,486
Per cent of grand total	3.58	-----	-----	-----	-----	-----	-----	-----	-----	0.47
Running into or striking objects										
Nails or wire	64	1	-----	1	2	46	2	3	9	1,337
Miscellaneous	214	7	6	4	25	108	7	24	33	2,312
Total	278	-----	-----	-----	-----	-----	-----	-----	-----	3,649
Per cent of grand total	4.40	-----	-----	-----	-----	-----	-----	-----	-----	0.70
Struck by moving objects										
Caught between objects and materials	286	-----	-----	-----	20	181	14	52	19	7,339
Struck by objects	326	6	29	21	36	54	38	80	62	12,863
Total	[2] 612	-----	-----	-----	-----	-----	-----	-----	-----	20,202
Per cent of grand total	9.70	-----	-----	-----	-----	-----	-----	-----	-----	3.86
Struck by falling objects										
From derrick	[3] 165	2	42	5	27	17	11	49	12	41,795
Tools and materials	[4] 237	1	17	6	11	34	19	109	40	29,811
Total	[5] 402	-----	-----	-----	-----	-----	-----	-----	-----	71,606
Per cent of grand total	6.37	-----	-----	-----	-----	-----	-----	-----	-----	13.70
Dropping objects (not handled by injured)										
Tools or materials	[6] 191	2	2	-----	4	27	8	144	4	22,590
Per cent of grand total	3.03	-----	-----	-----	-----	-----	-----	-----	-----	4.32

(See notes at end of table.)

TABLE 2.—*Drilling and producing accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Foot, ankle, toes	Legs	
Falls of persons										
Slipping and tripping	373	------	12	5	31	33	118	84	90	6,246
Into holes or unprotected places	[6] 101	1	1	1	3	1	17	40	37	14,162
From derrick	[7] 65	1	9	3	15	4	10	12	11	56,263
From derrick ladder	23	------	1	------	3	3	12	2	2	407
From ladders and scaffolds	54	------	------	4	10	4	19	8	9	1,427
From automobiles, trucks	37	------	2	2	4	5	11	1	12	905
From other elevations	[8] 50	------	5	1	8	4	14	10	8	18,896
Total	[9] 703	------	------	------	------	------	------	------	------	98,306
Per cent of grand total	11.14	------	------	------	------	------	------	------	------	18.80
Hand tools										
Hammers, hatchets	112	2	3	3	3	69	6	14	12	1,391
Wrenches	[2] 59	------	3	5	13	28	4	2	4	6,674
Tongs	25	------	1	3	2	7	6	6	------	181
Jacks, pries, bars, etc	64	1	5	8	3	11	8	21	7	1,001
Miscellaneous	60	2	4	1	3	30	3	11	6	493
Total	[2] 320	------	------	------	------	------	------	------	------	9,740
Per cent of grand total	5.07	------	------	------	------	------	------	------	------	1.86
Automobiles, trucks, and tractors										
Repairing	21	1	1	1	3	11	1	1	2	515
Operating	96	------	5	3	18	37	19	5	9	8,534
Struck by	[2] 13	------	1	------	3	------	4	------	5	6,379
Miscellaneous	3	------	------	------	1	2	------	------	------	20
Total	[2] 133	------	------	------	------	------	------	------	------	10,448
Per cent of grand total	2.11	------	------	------	------	------	------	------	------	2.01
Vehicles										
Plows, scrapers, etc	11	------	------	------	1	1	5	1	3	125
Miscellaneous	6	------	------	------	1	------	1	2	2	67
Total	17	------	------	------	------	------	------	------	------	192
Per cent of grand total	0.27	------	------	------	------	------	------	------	------	0.04
Burns										
Gas and oil	[6] 61	3	2	25	3	21	5	------	2	12,950
Hot metal	41	10	------	1	7	15	1	5	2	423
Steam and hot water	[6] 108	4	2	18	31	6	19	5	23	13,756
Electricity	[2] 4	1	------	------	1	------	1	------	1	6,024
Acetylene	9	5	------	3	------	------	------	------	1	94
Miscellaneous	13	5	------	2	2	2	1	------	1	164
Total	[10] 236	------	------	------	------	------	------	------	------	33,411
Per cent of grand total	3.74	------	------	------	------	------	------	------	------	6.39
Flying objects										
Chips from material	179	153	1	4	7	8	------	1	5	5,749
Chips from tools	18	11	------	------	3	2	------	------	2	542
Particles from grinding wheels	17	16	------	------	------	------	------	------	1	68
Flying particles	333	328	1	2	1	1	------	------	------	3,010
Miscellaneous	65	59	1	2	1	1	------	------	1	2,277
Total	612	------	------	------	------	------	------	------	------	11,646
Per cent of grand total	9.70	------	------	------	------	------	------	------	------	2.23
Machinery at drilling and producing wells										
Draw works:										
Drum	[4] 14	------	4	1	2	2	4	1	------	24,216
Sprockets	[2] 6	------	------	------	------	2	2	2	------	6,102
Chains	[2] 61	1	7	3	5	16	7	10	12	10,053
Shaft	4	------	------	------	1	2	------	------	1	254
Cathead	[3] 68	------	5	------	23	30	4	1	5	41,754
Clutch, etc	52	------	3	7	7	10	6	5	14	791

(See notes at end of table.)

TABLE 2.—*Drilling and producing accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Foot, ankle, toes	Legs	
Rotary engine:										
Flywheel	5				2	2	1			135
Sprocket	4		1			2			1	95
Eccentrics	18				1	5	1	4	7	699
Miscellaneous	4					2			2	99
Rotary table:										
Shaft, gears, sprockets	17			1		5		11		312
Miscellaneous	3							2	1	219
Pumps	40	3	2	2	2	24	2		5	3, 330
Calf wheel:										
Sprocket, chain	1							1		2
Miscellaneous	7		1	1		2	2	1		82
Bull wheel:										
Pegs, shaft, etc	[2] 12		2		2	4		3	1	6, 491
Ropes	[2] 14			2	4	1	4	1	2	6, 256
Band wheel:										
Belt	2						1		1	28
Shaft and miscellaneous	2					1		1		60
Standard engine:										
Flywheel	3				1	2				76
Pulley, belt	5		2		1	2				148
Miscellaneous	1							1		392
Pitman	6					3		3		70
Walking beam: Falling from	3						2	1		80
Stuffing box: Polish rod, grip, etc	33		4		2	24	1	1	1	2, 439
Gas engine:										
Flywheel	[2] 4		2					1	1	6, 035
Gears, clutch, etc	8		1		1	6				817
Cranking	7					4	2	1		51
Motor: Pulley, shaft, gears	4					4				1, 056
Traveling blocks:										
Hit by	12				2	5		3	2	958
Caught in	73				3	70				9, 744
Miscellaneous	4					4				64
Levers	32	1	9	10		3	6	2	1	689
Crown blocks:										
Caught in	9		1			8				98
Hit by falling	1					1				3
Elevators:										
Hit by falling	46		3		3	8	5	23	4	1, 839
Caught between slips, etc	109				1	98	1	9		9, 406
Caught in, latching	148				4	140	2	2		4, 868
Breaking of lines:										
Casing line	[8] 10		1		5		3		1	18, 152
Sand line	[2] 4	1	2						1	6, 100
Cat or jerk line	20	1	2	3	4	4	3		3	281
Casing tongs:										
Struck by	[6] 267	4	41	16	40	37	83	6	40	19, 375
Caught in	61					59	2			982
Hit by falling	25		3			4	1	17		384
Rotary hose	8	1	1	1	3		2			70
Sand reel	5			1	1	1	1		1	58
Caught in lines	[2] 26		1		2	14	1	2	6	6, 491
Miscellaneous	11					6	2	1	2	191
Total	[1]12,79									191, 895
Per cent of grand total	20. 27									36. 71
Other machinery										
Shops	34	1			2	27	1	1	2	1, 984
Compressor plants	[2] 15	2	1	3	3	2	2		2	6, 547
Pumping jack plants	5				1	3		1		95
Miscellaneous	7				1	4	1	1		105
Total	[2] 61									8, 731
Per cent of grand total	0. 97									1. 67

(See notes at end of table.)

Original from UNIVERSITY OF MICHIGAN

TABLE 2.—*Drilling and producing accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Foot, ankle, toes	Legs	
Miscellaneous										
Gas explosion	[6] 34	2		21	3	3	4		1	12,817
Boiler flareback	81	1	1	59	7	9		1	3	1,260
Horses, mules, insects, poison oak, etc	9				2	2	1	2	2	101
Splinters	33	1	1		2	28			1	770
Wickers	118	2	1		6	103		2	4	1,262
Gassed	12						12			89
Horseplay	1		1							21
Miscellaneous	[2] 33	1	4	1	4	17	3	2	1	7,128
Total	[8] 321									23,448
Per cent of grand total	5.09									4.48

[1] Includes 59 fatal accidents.
[2] Includes 1 fatal accident.
[3] Includes 6 fatal accidents.
[4] Includes 4 fatal accidents.
[5] Includes 10 fatal accidents.
[6] Includes 2 fatal accidents.
[7] Includes 8 fatal accidents.
[8] Includes 3 fatal accidents.
[9] Includes 13 fatal accidents.
[10] Includes 5 fatal accidents.
[11] Includes 22 fatal accidents

TABLE 3.—*Summary of data regarding causes and number of injuries, by extent of disability and total days lost resulting from each class of injuries*

Cause of accident	Number of injuries						Severity of injuries	
	Total	Deaths	Permanent partial disability	Temporary disability			Total time lost, days	Per cent of total time lost
				15 days or over	8 to 14 days	1 to 7 days		
All causes	6,310	59	253	1,697	1,030	3,271	522,751	100.00
Heavy lifting and straining	525		1	153	94	277	8,767	1.68
Dropping objects or materials handled	394		2	119	59	214	5,634	1.08
Stepping on objects	226		1	33	42	150	2,486	.47
Running into or striking objects	278		4	53	62	159	3,649	.70
Struck by moving objects	612	1	17	174	98	322	20,202	3.86
Struck by falling objects	402	10	13	125	63	191	71,606	13.70
Dropping objects (not handled)	191	2	24	72	43	50	22,590	4.32
Falls of persons	703	13	13	251	120	306	98,306	18.80
Hand tools	320	1	2	60	56	201	9,740	1.86
Automobiles, trucks, etc	133	1	5	64	19	44	10,448	2.01
Vehicles	17			4	4	9	192	.04
Burns	236	5		59	51	121	33,411	6.39
Flying objects	612		14	29	52	517	11,646	2.23
Machinery at drilling and producing wells	1,279	22	145	408	191	513	191,895	36.71
Other machinery	61	1	5	19	11	25	8,731	1.67
Miscellaneous	321	3	7	74	65	172	23,448	4.48

CAUSES OF INJURIES AND EXTENT OF DISABILITY

Table 3 tabulates the number of injuries and the corresponding time in days lost by cause of injury. The 59 drilling and production fatalities indicate the hazards incidental to the drilling for and the production of oil and gas. The 253 permanent partial disabilities also illustrate oil-field hazards. The effects of such injuries have not only been felt by a worker whose earning power has been reduced thereby but more often by his dependents. The loss of a limb may thus handicap a man for life.

PART OF BODY AFFECTED

Table 4 shows the number of accidents and the days lost, classified as to the part of the body affected. Hands and fingers received the greatest number of injuries; injuries of the head were by far the most serious, however, and caused the greatest loss of time, because many grave accidents, some of them fatal, were caused by material falling onto the employee's head or by the employee falling from an elevation and fracturing his skull. Second, in point of loss of time caused, come injuries to the trunk and back. Twenty-one such accidents were fatal. Contrary to the general opinion prevalent in the oil fields, injuries caused by heavy lifting and straining accounted for only a small fraction of the days lost through accidents affecting the trunk and back, although the number of such injuries was the greatest chargeable to any single subdivision in Table 2.

TABLE 4.—*Summary of data regarding the part of the body affected*

Part of body affected	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All parts	6,310	100.00	522,751	100.00
Eyes	644	10.21	15,097	2.89
Head	264	4.18	179,283	34.30
Face	266	4.21	4,037	.77
Shoulders, arms	519	8.23	24,714	4.73
Hands, fingers	1,680	26.62	66,866	12.79
Trunk, back	1,002	15.88	143,362	27.42
Feet, ankles, toes	1,311	20.78	37,253	7.13
Legs	624	9.89	52,139	9.97

AVERAGE NUMBER OF DAYS LOST PER ACCIDENT

It is interesting to note the high average number of days lost per accident due to various causes, as shown in Table 5. The seriousness of oil-field accidents is exemplified by the average of 11 days lost for every accident due to stepping on such objects as nails, loose boards, or clods of earth and by the average of 178.12 days lost for every accident due to a person being struck by a falling object. The magnitude of the accident-prevention problem in petroleum fields is clearly shown when one takes account of the fact that for every lost-time accident in the California drilling and producing fields in 1923 an average of 82.84 days was lost.

TABLE 5.—*Summary of data regarding the average number of days lost per accident, by causes*

Cause of accident	Number of accidents	Time lost, days	Average number of days lost per accident
All causes	6,310	522,751	82.84
Stepping on objects	226	2,486	11.00
Vehicles	17	192	11.29
Running into or striking objects	278	3,649	13.12
Dropping objects or materials handled	394	5,634	14.30
Heavy lifting and straining	525	8,767	16.69
Flying objects	612	11,646	19.03
Hand tools	320	9,740	30.43
Struck by moving objects	612	20,202	33.01
Miscellaneous causes	321	23,448	73.05
Automobiles, trucks, and tractors	133	10,448	78.55
Dropping objects not handled	191	22,590	118.27
Falls of persons	703	98,306	139.83
Burns	236	33,411	141.57
Other machinery	61	8,731	143.13
Machinery at wells	1,279	191,895	150.03
Falling objects	402	71,606	178.12

CLASSIFICATION OF OIL-FIELD LABOR

In order to determine which class of workers in the drilling and producing division of the oil industry is most susceptible to accidents, oil-field labor has been classified into 13 groups. From this classification and the data in Table 2 the summary in Table 6 has been compiled. As mentioned in this report, the drilling crews, which represent the largest percentage of oil-field labor, suffered the most accidents and sustained the greatest loss of time. Next in number of accidents and days lost come the roustabouts or common laborers, followed closely as regards the seriousness of the accidents by the producing crews. Shopmen rank quite high in the number of accidents and in the total number of days lost. Many of these accidents were caused by dropping material handled by the injured or were eye accidents that could have been prevented by wearing goggles.

The 13 groups of oil-field labor are as follows:

(1) **Drilling crews** (includes rotary drillers, derrick men, cathead men, helpers, cable-tool drillers, tool dressers, and circulator men).

(2) **Producing crews** (includes well cleaners, well pullers, and helpers).

(3) **Rig builders and helpers.**

(4) **Engineers and firemen.**

(5) **Pumpers and oilers** (includes gaugers).

(6) **Teamsters** (includes helpers and stablemen).

(7) **Truck and tractor drivers** (includes swampers and helpers).

(8) **Plant operators** (includes engineers, oilers, wipers, helpers, absorption-plant operators, and dehydrating-plant operators).

(9) **Roustabouts and laborers** (includes common and semiskilled laborers and yardmen).

(10) **Garage men** (includes mechanics and helpers).

(11) Craftsmen (includes carpenters, painters, electricians, plumbers, tinsmiths, brick masons, and helpers).

(12) Shopmen (includes machinists, blacksmiths, welders, boilermakers, gas-engine repairmen, and helpers).

(13) Miscellaneous (includes cooks, waiters, warehousemen, clerks, watchmen, janitors, and miscellaneous).

TABLE 6.—*Summary of data regarding accidents and days lost, by occupation of injured*

Occupation	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All occupations	6,310	100.00	522,751	100.00
Drilling crews	3,784	59.97	334,806	64.05
Producing crews	355	5.62	32,246	6.17
Rig builders	112	1.78	16,352	3.13
Engineers and firemen	122	1.93	15,888	3.04
Pumpers and oilers	114	1.81	21,886	4.19
Teamsters	26	.41	540	.10
Truck and tractor drivers	295	4.68	7,631	1.46
Plant operators	46	.73	12,803	2.45
Roustabouts and laborers	784	12.42	35,471	6.78
Garage men	40	.63	832	.16
Craftsmen	128	2.03	3,643	.70
Shopmen	403	6.39	26,874	5.14
Miscellaneous	101	1.60	13,779	2.63

ACCIDENTS CAUSED BY THE MACHINERY AT DRILLING AND PRODUCING WELLS

Because the machinery at the wells was responsible for a large percentage of drilling and production accidents, Table 7 has been prepared to show by percentages the part various pieces of machinery played in the cause and gravity of the total machinery accidents.

The 1,279 well-machinery accidents (Table 5), occasioning 191,895 days of disability, have been grouped in Table 7 by 23 classifications and the data expressed in per cent of total well-machinery accidents and per cent of total days lost as a result of these accidents.

TABLE 7.—*Summary of data on accidents caused by machinery at drilling and producing wells*

Part	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All machinery	1,279	100.00	191,895	100.00
Draw works	205	16.03	83,170	43.34
Rotary engine	31	2.42	1,028	.53
Rotary table	20	1.56	531	.28
Pumps	40	3.13	3,330	1.74
Calf wheel	8	.63	84	.04
Bull wheel	26	2.03	12,747	6.64
Band wheel	4	.31	88	.05
Standard engine	9	.70	616	.32
Pitman	6	.47	70	.04
Walking beam	3	.24	80	.04
Stuffing box, grip, polish rod	33	2.58	2,439	1.27
Gas engine	19	1.49	6,903	3.60
Electric motor	4	.31	1,056	.55
Traveling blocks	89	6.96	10,766	5.61
Levers	32	2.50	680	.36
Crown blocks	10	.78	101	.05
Elevators	303	23.69	16,113	8.40
Breaking of lines	34	2.66	24,533	12.78
Casing and tubing tongs	353	27.60	20,741	10.81
Rotary hose	8	.63	70	.04
Sand reel	5	.39	58	.03
Caught in lines	26	2.03	6,491	3.38
Miscellaneous	11	.86	191	.10

PIPE-LINE AND TRANSPORTATION ACCIDENTS

Table 8 tabulates accidents to the workers engaged in general pipe-line work and in the transportation of oil from the fields to refineries and loading wharves. This classification includes accidents which occurred in the building of pipe lines and in the erection of tanks and other storage facilities. Falls of persons were the outstanding cause of pipe-line and transportation accidents. The resultant loss of time amounted to 68.01 per cent of all time lost in this division. Three men lost their lives, and many were injured in falling from ladders and scaffolds; one fatality was due to a fall from a moving truck. Scaffold accidents can usually be prevented by building safe scaffolds for the men to work on. Much of the blame for such accidents can be charged against supervision, for no foreman should allow his men to work on improperly constructed or weak scaffolds. The erection of steel tanks is a hazardous occupation. Men frequently fall from ladders and scaffolds or from the tanks, and innumerable accidents occur from workers dropping plates on fingers or toes, being struck by swinging or falling plates, mashing fingers under hand tools, and getting scale or rust in the eyes.

Little can be done to provide mechanical guards on construction work of this nature other than to insist upon well-built scaffolding and adequate runways with guardrails. Competent supervision and accident-prevention work along educational lines, however, will do much to reduce the number of avoidable accidents. In such work the foreman, more than anyone else, is the key man and his cooperation is absolutely necessary. No matter how cheaply or quickly a foreman can do the work, he can not be considered efficient if his men sustain frequent injuries.

Table 8 classifies and tabulates by causes the accidents in pipe-line and transportation work in 1923. Of the 667 accidents listed, 72 were caused by flying objects, many of them chips from rivets being driven, or scale and rust flying in the air and lodging in the eyes of workmen. No better-paying investment can be made in tank construction than to provide goggles for every employee connected with the driving of rivets and calking of tanks. However, after goggles are provided for every man whose work requires protection for the eyes, it is essential to see that they are used.

TABLE 8.—*Pipe-line and transportation accidents, classified by causes*

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Feet, ankles, toes	Legs	
All causes										
All causes	[1] 667	84	33	21	56	147	126	141	59	39, 826
Per cent	100. 00	------	------	------	------	------	------	------	------	100. 00
Heavy lifting and straining										
Heavy lifting and straining	70	------	------	------	2	2	59	1	6	809
Per cent of grand total	10. 49	------	------	------	------	------	------	------	------	2. 03
Dropping objects and materials handled										
Dropping objects or materials	45	------	------	------	------	9	------	29	7	600
Per cent of grand total	6. 75	------	------	------	------	------	------	------	------	1. 51
Stepping on objects										
Nails	28	------	------	------	------	------	------	28	------	241
Miscellaneous	9	------	------	1	------	------	------	7	1	53
Total	37	------	------	------	------	------	------	------	------	294
Per cent of grand total	5. 55	------	------	------	------	------	------	------	------	0. 74
Running into or striking objects										
Nails, wire	5	------	------	------	1	2	------	1	1	21
Miscellaneous	41	3	1	------	2	26	4	1	4	557
Total	46	------	------	------	------	------	------	------	------	578
Per cent of grand total	6. 90	------	------	------	------	------	------	------	------	1. 45
Struck by moving objects										
Caught between objects and materials	29	------	------	------	------	21	1	6	1	531
Struck by objects	26	1	2	4	------	2	6	10	1	1, 135
Total	55	------	------	------	------	------	------	------	------	1, 666
Per cent of grand total	8. 24	------	------	------	------	------	------	------	------	4. 18
Struck by falling objects										
Materials	37	1	8	------	4	6	5	9	4	1, 070
Tools	11	------	3	------	2	3	------	1	2	96
Total	48	------	------	------	------	------	------	------	------	1, 166
Per cent of grand total	7. 20	------	------	------	------	------	------	------	------	2. 93

[1] Includes 4 fatal accidents.

TABLE 8.—*Pipe-line and transportation accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Feet, ankles, toes	Legs	
Dropping objects (not handled by injured)										
Dropping objects	14			1	2	4	1	6		212
Per cent of grand total	2.10									0.54
Falls of persons										
Slipping and tripping	37			1	6		13	10	7	352
Into holes and unprotected places	8		1		1		1	3	2	175
From tanks	7		1			1	1	1	3	153
From ladders and scaffolds	[2] 34		8	1	8	1	7	6	3	20,010
From trucks, automobiles, etc	[3] 9		1		3		1	2	2	6,272
Miscellaneous	5		2				3			125
Total	[1] 100									27,087
Per cent of grand total	14.99									68.01
Hand tools										
Hammers, hatchets, etc	15					10		3	2	242
Wrenches	9		1	1	1	6				85
Tongs	9				2	1	1	5		67
Jacks, pries, bars, etc	9					5	2	2		109
Miscellaneous	14				1	6	2	4	1	195
Total	56									698
Per cent of grand total	8.39									1.75
Automobiles, trucks, and tractors										
Repairing	2						2			8
Operating	10		1		4	2	2		1	436
Struck by	8			1	1		3	1	2	130
Miscellaneous	1				1					276
Total	21									850
Per cent of grand total	3.15									2.13
Vehicles										
Plows, scrapers	6						2	2	2	95
Wagons and miscellaneous	2						1	1		27
Total	8									122
Per cent of grand total	1.20									0.31
Burns										
Gas, oil	18	3	1	6	4	4				361
Hot metal	6	3	1		1	1				25
Steam, hot water	6	1		1	2				2	140
Electricity	6	5			1					33
Acetylene and oxygen	1								1	9
Total	37									568
Per cent of grand total	5.55									1.43
Flying objects										
Chips from materials	32	30		1		1				945
Chips from tools	2					1			1	30
Flying particles	38	37			1					733
Total	72									1,708
Per cent of grand total	10.79									4.29
Machinery										
Shops	6				2	3		1		76
Etching machines	1					1				30
Pumping plants	11					9			2	2,110
Miscellaneous	9		1		1	4	2	1		350
Total	27									2,566
Per cent of grand total	4.05									6.44

[1] Includes 4 fatal accidents. [2] Includes 3 fatal incidents. [3] Includes 1 fatal accident.

TABLE 8.—*Pipe-line and transportation accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Feet, ankles, toes	Legs	
Miscellaneous										
Gas explosion	2		1	1						37
Flareback under boiler	1			1						26
Horses, mules, insects, etc	3						3			17
Splinters	6				1	5				43
Wickers	7				1	6				107
Gassed	2						2			5
Miscellaneous	10			1	1	5	2		1	667
Total	31									902
Per cent of grand total	4.65									2.26

CAUSES OF INJURIES AND EXTENT OF DISABILITY

In Table 9 the injuries by causes have been tabulated by extent of disability and total days lost as a result of each class of injury. Falls of persons accounted for 68.01 per cent of total days lost. Accidents caused by machinery come second, with 6.44 per cent. The latter occurred mainly at the pumping plants along the pipe lines and were caused by workmen getting their fingers between moving parts of the pumping machinery while oiling or feeling bearings or wiping and cleaning engines and pumps that were in operation.

TABLE 9.—*Summary of data regarding causes and number of injuries, by extent of disability and total days lost from each class of injury*

Cause of accident	Number of injuries						Severity of injuries	
	Total	Deaths	Permanent partial disability	Temporary disability			Total time lost, days	Per cent of total time lost
				15 days or over	8 to 14 days	1 to 7 days		
All causes	667	4	21	164	111	367	39,826	100.00
Heavy lifting and straining	70			20	11	39	809	2.03
Dropping objects or materials handled	45			11	5	29	600	1.51
Stepping on objects	37			3	11	23	294	.74
Running into or striking objects	46		2	8	10	26	578	1.45
Struck by moving objects	55		3	14	8	30	1,666	4.18
Struck by falling objects	48		1	17	7	23	1,166	2.93
Dropping objects not handled	14			7	3	4	212	.54
Falls of persons	100	4	3	33	17	43	27,087	68.01
Hand tools	56		1	11	12	32	698	1.75
Automobiles, trucks, and tractors	21			10	4	7	850	2.13
Vehicles	8			3	2	3	122	.31
Burns	37			10	6	21	568	1.43
Flying objects	72		3	5	4	60	1,708	4.29
Machinery	27		6	7	5	9	2,566	6.44
Miscellaneous	31		2	5	6	18	902	2.26

PART OF BODY AFFECTED

As is to be expected in all occupations where hand labor predominates, the extremities received the greatest number of injuries. (Table 10.) The trunk and back follow closely, with 126 accidents, causing a loss of 1,834 days. The small number of days lost is surprising for the heavy work that is done in the erection of tanks and the laying of pipe lines and seems to demonstrate the efficacy of teamwork among groups of workers. The days lost because of injuries to the head represent 46.44 per cent of the total; the percentage is so high because three workers fractured their skulls.

TABLE 10.—*Summary of data on the part of the body affected*

Part of the body affected	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All parts	667	100.00	39,826	100.00
Eyes	84	12.59	2,573	6.46
Head	33	4.95	18,495	46.44
Face	21	3.15	206	.52
Shoulders, arms	56	8.40	2,351	5.90
Hands, fingers	147	22.04	4,904	12.31
Trunk, back	126	18.89	1,834	4.61
Feet, ankles, toes	141	21.13	2,743	6.89
Legs	59	8.85	6,720	16.87

AVERAGE NUMBER OF DAYS LOST PER ACCIDENT

The average number of days lost per accident by pipe line and transportation in 1923, as shown in Table 11, was 59.71 days. The time lost per accident ranged from 7.94 days for injuries resulting from workers stepping on objects, principally nails, to an average of 270.87 days lost per accident due to falls of persons. Organized safety work is perhaps the only method which can be employed to combat effectively the large number of accidents resulting from falls of persons. Fifteen per cent of all the accidents in the pipe-line and transportation division were so caused, and slightly more than a third of these were the result of workmen slipping or tripping over objects or materials carelessly left in pathways and working places. Another third of the accidents due to falls of persons were the result of workmen falling from ladders and scaffolds. Such accidents can only be prevented by the eternal vigilance of foremen and by the continual watchfulness of employees working on elevations.

TABLE 11.—*Summary of data regarding the average number of days lost per accident, by causes*

Cause of accident	Number of accidents	Time lost, days	Average time lost per accident
All causes	667	39,826	59.71
Stepping on objects	37	294	7.94
Heavy lifting and straining	70	809	11.55
Hand tools	56	698	12.46
Running into or striking objects	46	578	12.56
Dropping objects or material handled	45	600	13.33
Dropping objects not handled	14	212	15.14
Vehicles	8	122	15.25
Burns	37	568	15.35
Flying objects	72	1,708	23.72
Struck by falling objects	48	1,166	24.29
Miscellaneous	31	902	29.09
Struck by moving objects	55	1,666	30.29
Automobiles, trucks, tractors	21	850	40.47
Machinery	27	2,566	95.03
Falls of persons	100	27,087	270.87

CLASSIFICATION OF PIPE-LINE AND TRANSPORTATION LABOR

Grouping pipe-line and transportation employees into nine classifications reveals the hazards incidental to tank construction as compared to other work in this division. The erection of tankage caused 57 per cent of the total time lost, although the number of accidents befalling the roustabout or common-labor group, which includes pipe-line construction labor, was more than twice as great as that sustained by tank builders and erectors. From the data given in Table 11 it can safely be said that new construction caused 75 to 85 per cent of the accidents and a like percentage of the number of days lost because of accidents in this division for 1923.

A classification of pipe-line and transportation labor follows; with this as a basis and the data given in Table 8, the summary in Table 12 has been compiled.

(1) Station attendants (includes engineers, firemen, and heaters).

(2) Truck and tractor drivers (includes swampers and helpers).

(3) Teamsters (includes helpers and stablemen).

(4) Gaugers.

(5) Shopmen (includes machinists, boiler makers, boiler washers, garage men, and helpers).

(6) Craftsmen (includes carpenters, electricians, painters, cement men, and helpers).

(7) Roustabouts and common laborers (includes pipe-line crews).

(8) Tank builders and erectors (includes riveters, heaters, buckers-up, holders-on, calkers, chippers, tank laborers, and helpers).

(9) Miscellaneous labor (includes line walkers, warehousemen, yardmen, gardeners, car loaders, superintendents, and miscellaneous).

TABLE 12.—*Summary of data regarding accidents and days lost, by occupation of the injured*

Occupation	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All occupations	667	100.00	39,826	100.00
Station attendants	40	6.00	2,470	6.20
Truck drivers	16	2.40	382	.96
Teamsters	8	1.20	164	.41
Gaugers	8	1.20	296	.75
Shopmen	105	15.74	917	2.30
Craftsmen	38	5.69	634	1.59
Roustabouts and laborers	298	44.68	11,913	29.91
Tank builders and erectors	130	19.49	22,699	57.00
Miscellaneous labor	24	3.60	351	.88

REFINERY ACCIDENTS

The accidents tabulated in Table 13 occurred to employees working in and about California refineries during 1923. This table also includes accidents that were incidental to the actual refining of oil, such as container-manufacturing and construction accidents.

Of the eight fatalities to refinery employees during 1923 three were due to failure of a look box, two to materials falling on workmen, two to workmen falling from ladders and scaffolds, and one to a hoist engineer being caught in the hoisting rope, so that he was wound around the gypsy head of a mechanically operated portable hoist.

Most California refineries have done excellent work in making their plants and surroundings safe for their employees. The causes of accidents shown in Table 13 indicate that future effort in accident prevention should be along educational lines as well as safeguarding machinery.

The prevention of look-box failures depends on the design, not only of the look box itself but especially of the vapor-relief apparatus between the condenser coils and the look box. The necessity for such relief exists at all times but is imperative if the supply of cooling water to the condensers should be cut off. Good practice also calls for an additional vapor vent from the look box itself; such a vent should be properly protected against ignition by escaping vapor. Wire glass should be used for look-box windows. Where such design has not been used, look-box failures may occur and tail houses be filled with highly inflammable gases. As these gases are heavy and may travel great distances, all fires should be immediately extinguished under near-by stills and boilers if liquid or vapor leaks from broken or defective look boxes.

Workmen and foremen alike should be instructed that their safety depends on keeping ladders and elevated places safe. Loose tools and material should never be allowed to remain unsecured where there is the slightest chance that they may fall on workmen. The severity of the accidents from this latter cause alone shows the importance of care by workers and foremen.

The numerous strains due to heavy lifting, not only at refineries but in all branches of the California petroleum industry, suggest that men are either being called upon or are taking it upon themselves to lift loads that are too heavy to handle safely. Accidents due to heavy lifting and straining, dropping objects handled, stepping on objects and running into or striking objects, show the need for a concerted educational effort in accident prevention.

Nine workers were overcome by gases during the year, with a resulting loss of 1,612 working days. Hose masks should be part of the equipment of every refinery and some responsible person should be placed in charge of them. His duties should be to keep the masks and blowers in working order, to clean and sterilize the masks immediately after they have been used, and to be entirely familiar with their use and limitations. Rubber deteriorates rapidly and should be moistened often to prolong wear. Masks and hose should never be stored in hot and dry places.

Table 13 classifies refinery accidents during 1923 as to causes. This table shows the number of accidents, the days lost for each cause, and the part of the body affected. The number of accidents and the days lost are also expressed in percentages of the total number of accidents and total number of days lost.

TABLE 13.—*Refinery accidents, classified by causes*

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Feet, ankles, toes	Legs	
All causes										
All causes	[1]930	89	43	44	63	196	194	217	84	72,620
Per cent of grand total	100.00	......	......	......	......	......	......	......	......	100.00
Heavy lifting and straining										
Heavy lifting and straining	123	......	......	......	9	7	97	......	10	1,621
Per cent of grand total	13.22	......	......	......	......	......	......	......	......	2.23
Dropping objects or materials handled										
Dropping objects or materials	84	......	......	......	2	12	3	62	5	1,077
Per cent of grand total	9.03	......	......	......	......	......	......	......	......	1.49
Stepping on objects										
Nails	20	......	......	......	......	......	......	20	......	90
Miscellaneous	30	......	......	......	......	......	3	26	1	402
Total	50	......	......	......	......	......	......	......	......	492
Per cent of grand total	5.38	......	......	......	......	......	......	......	......	0.55
Running into or striking objects										
Nails, wire	8	1	......	......	......	6	......	......	1	214
Miscellaneous	43	2	3	......	3	18	1	7	9	653
Total	51	......	......	......	......	......	......	......	......	867
Per cent of grand total	5.48	......	......	......	......	......	......	......	......	1.19

[1] Includes 8 fatal accidents.

TABLE 13.—*Refinery accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Feet, ankles, toes	Legs	
Struck by moving objects										
Caught between objects and materials	55	------	------	------	------	39	2	12	2	1,253
Struck by objects	35	------	5	2	2	3	5	9	9	410
Total	90	------	------	------	------	------	------	------	------	1,663
Per cent of grand total	9.68	------	------	------	------	------	------	------	------	2.29
Struck by falling objects										
Materials	[1] 37	1	9	------	4	3	6	12	2	13,270
Tools	13	------	4	2	2	1	1	3	------	271
Total	[1] 50	------	------	------	------	------	------	------	------	13,541
Per cent of grand total	5.38	------	------	------	------	------	------	------	------	18.65
Dropping objects (not handled by injured)										
Dropping objects	12	------	------	------	------	------	------	11	1	389
Per cent of grand total	1.29	------	------	------	------	------	------	------	------	0.54
Falls of persons										
Slipping and tripping	72	------	1	------	8	6	26	28	23	1,188
Into holes and unprotected places	16	------	------	------	1	------	4	6	5	379
From tanks	3	------	------	------	------	1	1	1	------	163
From ladders and scaffolds	[1] 49	1	6	------	9	5	8	10	10	15,162
From automobiles, trucks	10	------	------	1	------	------	3	4	2	155
Miscellaneous	9	------	1	1	------	1	2	1	3	154
Total	[1] 159	------	------	------	------	------	------	------	------	17,201
Per cent of grand total	17.10	------	------	------	------	------	------	------	------	23.69
Hand tools										
Hammers, hatchets	16	------	1	------	1	8	3	3	------	341
Wrenches	7	------	------	------	1	4	2	------	------	108
Tongs	2	------	------	------	1	1	------	------	------	523
Jacks, pries, bars, etc	5	------	------	------	1	1	------	2	1	28
Miscellaneous	17	------	1	------	1	11	1	2	1	231
Total	47	------	------	------	------	------	------	------	------	1,231
Per cent of grand total	5.05	------	------	------	------	------	------	------	------	1.70
Automobiles, trucks, and tractors										
Repairing	2	1	------	------	------	------	1	------	------	1,810
Operating	5	------	------	------	2	3	------	------	------	534
Struck by	5	------	1	------	------	------	------	3	1	153
Total	12	------	------	------	------	------	------	------	------	2,497
Per cent of grand total	1.29	------	------	------	------	------	------	------	------	3.43
Vehicles										
Plows, scrapers	2	------	1	------	------	------	1	------	------	31
Per cent of grand total	0.22	------	------	------	------	------	------	------	------	0.04
Burns										
Gas, oil	34	2	3	7	6	10	2	2	2	596
Hot metal	5	1	------	------	1	3	------	------	------	12
Steam, hot water	7	------	------	1	1	------	1	1	3	94
Electricity	14	12	------	------	------	2	------	------	------	73
Acetylene and oxygen	2	1	------	------	------	------	1	------	------	33
Acids and caustic	19	11	------	2	------	4	1	1	------	155
Miscellaneous	5	3	1	------	------	1	------	------	------	32
Total	86	------	------	------	------	------	------	------	------	995
Per cent of grand total	9.25	------	------	------	------	------	------	------	------	1.37

[1] Includes 2 fatal accidents.

TABLE 13.—*Refinery accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eye	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Feet, ankles, toes	Legs	
Flying objects										
Chips from materials	25	21		1	1	2				135
Chips from tools	3	2				1				507
From grinding wheels	4	4								43
Flying particles	21	21								296
Miscellaneous	4	3			1					63
Total	57									1,044
Per cent of grand total	6.13									1.44
Machinery										
Shops	7					5	2			1,063
Nailing machines	2					2				11
Hoists and cranes	[1] 3		1			1	1			6,017
Woodworking	5					5				866
Panel presses	2					2				666
Miscellaneous	7				1	4	2			209
Total	[1] 26									8,832
Per cent of grand total	2.80									12.16
Miscellaneous										
Gas explosion	13		2	8	1	2				225
Flareback, boiler or still	14			11	2	1				324
Still explosion	3		1			1	1			37
Look-box failures	[4] 9			5			4			18,203
Horses, mules, insects	9			2		4		1	2	94
Splinters	9					9				148
Wickers	5	1				3			1	21
Horseplay	1			1						1
Gassed	9	1	1				7			1,612
Miscellaneous	9		1		2	4	2			564
Total	[4] 81									21,229
Per cent of grand total	8.70									29.23

[1] Includes 1 fatal accident.

[4] Includes 3 fatal accidents.

CAUSES OF INJURIES AND EXTENT OF DISABILITY

That there was still some unguarded machinery in California refineries during 1923 is shown by the number of permanent disability cases listed under "Machinery" in Table 14. Indirectly machinery guards are responsible for much progress in accident prevention aside from the fact that they protect the workman from machinery hazards, in that they are a constant reminder that the management is concerned in protecting the employee from injury.

TABLE 14.—*Summary of data regarding causes and number of injuries, by extent of disability and total days lost resulting from each class of injuries*

Cause of accident	Number of injuries						Severity of injuries	
	Total	Deaths	Permanent partial disability	Temporary disability			Total time lost, days	Per cent of total time lost
				15 days or over	8 to 14 days	1 to 7 days		
All causes	930	8	23	288	146	465	72,620	100.00
Heavy lifting and straining	123			31	24	68	1,621	2.23
Dropping objects or materials handled	84		1	26	10	47	1,077	1.49
Stepping on objects	50			8	9	33	402	.55
Running into or striking objects	51		1	12	9	29	867	1.19
Struck by moving objects	90		3	30	20	37	1,663	2.29
Struck by falling objects	50	2	2	21	2	23	13,541	18.65
Dropping objects not handled by injured	12			6	1	5	389	.54
Falls of persons	159	2	2	60	22	73	17,201	23.69
Hand tools	47		1	15	9	22	1,231	1.70
Automobiles, trucks, tractors	12		2	8	1	1	2,497	3.43
Vehicles	2			1	1		31	.04
Burns	86			21	10	55	995	1.37
Flying objects	57		1	11	9	36	1,044	1.44
Machinery	26	1	6	11	3	5	8,832	12.16
Miscellaneous	81	3	4	27	16	31	21,229	29.23

PART OF BODY AFFECTED

Table 15 shows that injuries of the trunk and back caused the greatest loss of time, chiefly due to five fatal accidents in which injuries of the body proper were the cause of death. Injuries of the head rank second, principally because the three remaining refinery fatalities were due to such injuries. The large number of accidents causing injury to the feet were mainly due to three causes, dropping objects or material handled, stepping on objects, and falls of persons. Slipping and tripping alone resulted in 72 accidents, 28 of which caused injuries to the feet. Accidents of this kind show the direct relationship between plant orderliness and safety. In the number of accidents the hands and fingers rank second. Getting hands and fingers caught between a moving object and stationary material, or vice versa, caused 39 accidents. This again demonstrates how important is the watchfulness of the employee in preventing accidents.

TABLE 15.—*Summary of data regarding part of body affected*

Part of body affected	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All parts	930	100.00	72,620	100.00
Eyes	89	9.57	5,235	7.23
Head	43	4.63	18,883	26.00
Face	44	4.73	683	.94
Shoulders, arms	63	6.77	2,115	2.91
Hands, fingers	196	21.08	6,207	8.54
Trunk, back	194	20.86	32,774	45.13
Feet, ankles, toes	217	23.33	4,520	6.22
Legs	84	9.03	2,203	3.03

AVERAGE NUMBER OF DAYS LOST PER ACCIDENT

The average number of days lost per accident (Table 16) in California refineries is just 4.75 days per accident less than the average number lost per accident in drilling and producing (Table 5) during 1923.

Table 16 shows that the number of days lost from refinery accidents is relatively high.

TABLE 16.—*Summary of data regarding the average number of days lost per accident, by causes*

Cause of accident	Number of accidents	Time lost, days	Average number of days lost per accident
All causes	930	72,620	78.09
Stepping on objects	50	402	8.04
Burns	86	995	11.57
Dropping objects handled	84	1,077	12.82
Heavy lifting and straining	123	1,621	13.18
Vehicles	2	31	15.50
Running into or striking objects	51	867	17.00
Flying objects	57	1,044	18.31
Struck by moving objects	90	1,663	18.48
Hand tools	47	1,231	26.19
Dropping objects not handled by injured	12	389	32.42
Falls of persons	159	17,201	108.18
Automobiles, trucks, tractors	12	2,497	208.08
Miscellaneous	81	21,229	262.09
Struck by falling objects	50	13,541	270.82
Machinery	26	8,832	339.69

CLASSIFICATION OF REFINERY LABOR

When classified as to groups of workmen, the figures in Table 17 show that the work done by the shopmen in and around the refinery ranks first, both in number of accidents and days lost because of accidents. Roustabouts and common laborers rank second in number of injuries, whereas craftsmen are second in days lost because of accidents.

That these three groups of refinery workmen receive over two-thirds of all injuries and lose in consequence nearly two-thirds of the time lost verifies the general opinion that construction and repair work is by far the most dangerous work in and about a refinery.

Refinery labor is arranged in 14 groups. Table 17 shows the number of accidents and the time in days lost with percentages of each for the various groups of workmen.

(1) Container manufacturers (includes lumbermen, box makers, box nailers, coopers, drum and barrel washers, drum and barrel repairers, drum painters, and helpers).

(2) Compounders (includes grease and asphalt workers).

(3) Can and barrel fillers.

(4) Distillation crews (includes still men, firemen, pumpers, gaugers, receiving-house men, and helpers).

(5) Treaters (includes acid-sludge and refined-oil treaters).

(6) Filter men and clay burners.

(7) Engineers and firemen (includes power-plant operators).

(8) Teamsters (includes helpers and stablemen).

(9) Truck and tractor drivers (includes helpers).

(10) Shopmen (includes machinists, boiler makers, welders, blacksmiths, pipe fitters, lead burners, and salvage men).

(11) Craftsmen (includes carpenters, electricians, tinsmiths, painters, brick masons, and helpers).

(12) Roustabouts and common laborers (includes semiskilled laborers, riggers, and cement workers).

(13) Warehouse and shipping crews.

(14) Miscellaneous (includes crane operators, hoist engineers, locomotive engineers, gardeners, laboratory workers, messengers, foremen not otherwise classified, and watchmen).

TABLE 17.—*Summary of data regarding accidents and days lost, classified by occupation of injured*

Occupation	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All occupations	930	100.00	72,620	100.00
Container manufacturers	38	4.09	1,393	1.92
Compounders	2	.22	15	.02
Can and barrel fillers	21	2.26	360	.49
Distillation crews	44	4.73	12,914	17.78
Treaters	10	1.07	128	.18
Filter men and clay burners	4	.43	75	.10
Engineers and firemen	13	1.40	254	.36
Teamsters	23	2.47	260	.36
Truck and tractor drivers	19	2.04	2,558	3.52
Shopmen	331	35.59	24,041	33.10
Craftsmen	82	8.82	16,013	22.09
Roustabouts and laborers	275	29.57	7,122	9.81
Warehouse and shipping crews	22	2.36	444	.61
Miscellaneous	46	4.95	7,013	9.66

SALES AND MARKETING ACCIDENTS

Table 18 shows that the number of accidents and the corresponding days lost in the sales and marketing branch of the California petroleum industry for 1923 were less than in the other three branches of the industry. During the year there were four fatalities. A painter fell from a scaffold while painting a tank at an oil substation, a carpenter was thrown from his automobile while driving from one job to another, a truck driver was drowned when the truck he was driving ran off a ferry into a river, and another truck driver was fatally burned when his clothes, saturated with gasoline, caught fire.

Cranking trucks and automobiles and heavy lifting and straining were outstanding causes of injuries to workmen. The many minor injuries to service-station attendants included those caused by tire lock rims flying off and striking employees while inflating tires, getting fingers caught in the doors of customers' cars while wiping the windshields, being burned by hot water and steam when filling or preparing to fill radiators, and receiving cuts and scratches when gasoline tank caps were being screwed and unscrewed. In addition to these should also be listed the many injuries resulting from slipping and tripping while servicing cars and being run into by automobiles and trucks entering service-station yards.

Pumps at substations or oil-distributing plants caused two rather serious accidents; both could have been prevented if adequate guards had been in place around the moving parts of the oil pumps. Similarly, the four accidents due to fingers getting caught in the belts of the small air compressors at service stations could have been avoided by mechanical guards over the belts and pulleys. Men should be shown how to lift heavy objects correctly and how to crank a truck or automobile safely so a fractured or sprained wrist will not result if the engine should backfire; they should be told that a radiator is very much like a small steam boiler containing considerable stored-up energy when the water in it is boiling, and that cuts and scratches should receive immediate first-aid attention.

Table 18 classifies the 600 accidents to sales and marketing employees as to causes, showing the number of accidents and the time in days lost, with percentages for each of the 15 main causes. The part of the body affected is also shown.

TABLE 18.—*Sales and marketing accidents, classified by causes*

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Feet, ankles, toes	Legs	
All causes										
All causes	[1] 600	27	19	18	49	195	127	103	61	34,210
Per cent	100.00	------	------	------	------	------	------	------	------	100.00
Heavy lifting and straining										
Heavy lifting and straining	77	------	------	------	8	4	58	------	7	1,251
Per cent of grand total	12.83	------	------	------	------	------	------	------	------	3.66
Dropping objects or materials handled										
Dropping objects or materials	54	------	------	------	------	13	4	31	6	533
Per cent of grand total	9.00	------	------	------	------	------	------	------	------	1.56
Stepping on objects										
Nails	16	------	------	------	------	------	------	16	------	112
Miscellaneous	16	------	------	------	------	------	4	10	2	195
Total	32	------	------	------	------	------	------	------	------	307
Per cent of grand total	5.33	------	------	------	------	------	------	------	------	0.90
Running into or striking objects										
Nails, wire	3	------	------	------	------	3	------	------	------	17
Miscellaneous	55	------	2	------	3	34	2	6	8	404
Total	58	------	------	------	------	------	------	------	------	421
Per cent of grand total	9.67	------	------	------	------	------	------	------	------	1.23

[1] Includes 4 fatal accidents.

TABLE 18.—*Sales and marketing accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Feet, ankles, toes	Legs	
Struck by moving objects										
Caught between objects and materials	30				1	23			1	301
Struck by objects	32	1	3	5	4	8	4	3	4	449
Total	62									750
Per cent of grand total	10. 33									2. 19
Struck by falling objects										
Materials	7		2			3		2		71
Tools	4		3	1						26
Total	11									97
Per cent of grand total	1. 83									0. 28
Falls of persons										
Slipping and tripping	52		1	1	2	9	14	14	11	929
Into holes and unprotected places	6				1		2	2	1	103
From ladders and scaffolds	[1] 23		1	1	5	7	5	3	1	6, 426
From automobiles and trucks	11				1	2	3	2	3	366
Total	[1] 92									7, 824
Per cent of grand total	15. 34									22. 87
Hand tools										
Hammers, hatchets	10					9		1		227
Wrenches	4	1				3				22
Jacks, pries, bars, etc	2						1	1		18
Miscellaneous	1					1				22
Total	17									289
Per cent of grand total	2. 83									0. 84
Automobiles, trucks, and tractors										
Repairing	[1] 13				2	5	4		2	6, 474
Operating	[1] 81		7	3	16	34	19		2	7, 904
Struck by	25			2		2	3	9	9	423
Total	[2] 119									14, 801
Per cent of grand total	19. 84									43. 27
Burns										
Gas, oil	[1] 15	5		1	1	2	2		4	6, 207
Steam, hot water	3			3						15
Acetylene and oxygen	1	1								3
Miscellaneous	4				1	3				34
Total	[1] 23									6, 259
Per cent of grand total	3. 83									18. 30
Flying objects										
Chips from materials	4	4								23
Chips from tools	1				1					3
From grinding wheels	3	3								5
Flying particles	11	11								87
Total	19									118
Per cent of grand total	3. 17									0. 34
Machinery										
Shops	7					7				83
Pumps at stations	2					2				841
Air compressors	4					4				91
Total	13									1, 015
Per cent of grand total	2. 17									2. 97

[1] Includes 1 fatal accident.

[2] Includes 2 fatal accidents.

TABLE 18.—*Sales and marketing accidents, classified by causes*—Continued

Cause of accident	Number of accidents	Part of body affected								Time lost, days
		Eyes	Head	Face	Shoulders, arms	Hands, fingers	Trunk, back	Foot, ankle, toes	Legs	
Miscellaneous										
Gas explosion	1	------	------	------	------	------	------	1	------	42
Splinters	7	------	------	------	------	6	------	1	------	108
Wickers	3	------	------	------	------	3	------	------	------	55
Gassed	3	------	------	------	1	------	2	------	------	11
Miscellaneous	9	1	------	1	2	3	1	1	------	329
Total	23	------	------	------	------	------	------	------	------	545
Per cent of grand total	3.83	------	------	------	------	------	------	------	------	1.59

CAUSES OF INJURIES AND EXTENT OF DISABILITY

Table 19 shows the accidents classified by causes, with the extent of disability and the total days lost because of each class of injuries. All but 13 of the injuries to sales and marketing employees were minor and caused only temporary disability. However, the record can and should be materially improved. Many companies have clearly demonstrated that this is possible.

TABLE 19.—*Summary of data on cause and number of injuries, by extent of disability and total days lost from each class of injuries*

Cause of accident	Number of injuries						Severity of injuries	
	Total	Deaths	Permanent partial disability	Temporary disability			Total time lost, days	Per cent of total time lost
				15 days or over	8 to 14 days	1 to 7 days		
All causes	600	4	8	152	126	310	34,210	100.00
Heavy lifting and straining	77	-------	1	19	25	32	1,251	3.66
Dropping objects or materials handled	54	-------	-------	11	8	35	533	1.56
Stepping on objects	32	-------	-------	6	6	20	307	.90
Running into or striking objects	58	-------	-------	8	14	36	421	1.23
Struck by moving objects	62	-------	-------	15	8	39	750	2.19
Struck by falling objects	11	-------	-------	2	4	5	97	.28
Falls of persons	92	1	1	34	19	37	7,824	22.87
Hand tools	17	-------	1	5	3	8	289	.84
Automobiles, trucks, tractors	119	2	2	38	27	50	14,801	43.27
Burns	23	1	-------	4	4	14	6,259	18.30
Flying objects	19	-------	-------	3	2	14	118	.34
Machinery	13	-------	2	1	4	6	1,015	2.97
Miscellaneous	23	-------	1	6	2	14	545	1.59

PART OF BODY AFFECTED

Table 20 shows that injuries of the hands and fingers formed about one-third of the total number in the sales and marketing division for 1923. Ninety-six, or approximately one-half, of these were caused by not properly cranking automobiles or trucks, running into or striking objects such as ragged fenders or broken windshields, getting fingers pinched between barrels or drums of petroleum products while loading them on trucks, or getting fingers caught in automobile doors while wiping windshields of cars.

Heavy lifting and straining caused 58 of the 128 injuries to the trunk and back. Truck drivers suffered most of these injuries, which happened generally when they were moving filled drums of oil, handling case goods, or filling overhead tanks with oil from a bucket.

Dropping objects handled and stepping on objects caused over one-half of the accidents to the feet.

Since the injured themselves were responsible for the majority of accidents to sales and marketing employees, it is evident that instruction of personnel in safety work would be the best preventive. Some companies have obtained excellent results by circularizing their employees with posters, bulletins, and mimeographed copies of instructions on correct and proper methods of carrying on their work.

TABLE 20.—*Summary of data regarding the part of the body affected*

Part of the body affected	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All parts	600	100.00	34,210	100.00
Eyes	27	4.50	197	.58
Head	19	3.16	240	.70
Face	18	3.00	216	.63
Shoulders, arms	49	8.17	957	2.80
Hands, fingers	195	32.50	4,185	12.23
Trunk, back	128	21.33	26,082	76.24
Foot, ankle, toes	103	17.17	1,359	3.97
Leg	61	10.17	974	2.85

AVERAGE NUMBER OF DAYS LOST PER ACCIDENT

Table 21 shows that an average of 57.01 days was lost per accident by sales and marketing employees during 1923. This figure is very nearly the same as that for pipe-line and transportation workers, where the number of days lost per accident was 59.71.

TABLE 21.—*Summary of data on the average number of days lost per accident, by causes*

Cause of accident	Number of accidents	Time lost, days	Average number of days lost per accident
All causes	600	34,210	57.01
Flying objects	19	118	6.21
Running into or striking objects	58	421	7.26
Machinery	13	1,015	7.81
Struck by falling objects	11	97	8.81
Stepping on objects	32	307	9.59
Dropping objects handled by injured	54	533	9.87
Struck by moving objects	62	750	12.10
Heavy lifting and straining	77	1,251	16.24
Hand tools	17	289	17.00
Miscellaneous	23	545	23.70
Falls of persons	92	7,824	85.04
Automobiles, trucks, tractors	119	14,801	124.37
Burns	23	6,259	272.13

CLASSIFICATION OF SALES AND MARKETING LABOR

When the accidents in the sales and marketing group are classified by the occupation of the injured, as in Table 22, the seriousness of injuries to truck drivers can not be questioned. Craftsmen, of whom painters were in the majority, rank second and service-station attendants third. However, on the basis of number of accidents, service-station attendants rank first, followed closely by truck drivers, who, out of a total of 600 sales-division accidents, received 158, or 11 less than the men selling gasoline and oils at service stations.

An analysis of sales-division labor follows, in which the employees have been grouped into seven divisions; from this classification and the data given in Table 19 the summary in Table 22 has been compiled.

(1) Service-station attendants (includes station salesmen and air and water boys).

(2) Truck drivers (includes tank-truck salesmen and helpers).

(3) Warehousemen (includes warehouse laborers, yardmen, and watchmen).

(4) Craftsmen (includes carpenters, painters, and steel workers).

(5) Laborers (includes common laborers, concrete workers, and gardeners).

(6) Garage men (includes mechanics, car washers, and helpers).

(7) Miscellaneous (includes collectors, salesmen, clerks, and miscellaneous).

TABLE 22.—*Summary of data on accidents and days lost, classified as to the occupation of the injured*

Occupation	Number of accidents	Per cent of total accidents	Time lost, days	Per cent of total time lost
All occupations	600	100.00	34,210	100.00
Service-station attendants	169	28.17	2,491	7.28
Truck drivers	158	26.34	20,843	60.93
Warehousemen	95	15.83	1,425	4.17
Craftsmen	50	8.33	6,924	20.24
Laborers	35	5.83	347	1.01
Garage men	62	10.33	1,865	5.45
Miscellaneous	31	5.17	315	.92